

**REMARKS**

This application is amended in a manner to place it in condition for allowance at the time of the next Official Action.

**Status of the Claims**

Claim 11 has been amended to include the features from claims 12 and 13.

Claims 1, 3-6, 15-19 and 24-26 are amended as to form.

Claims 12, 13 and 22 have been cancelled.

Claims 1-11 and 14-27 remain pending.

Claims 1-10, 20 and 21 have been withdrawn for being directed to a non-elected invention.

**Claim Objections**

Claim 11 was objected because of informalities.

Applicant acknowledges with appreciation the Examiner's helpful suggestions to overcome the objection. These suggestions have been incorporated into the claim. Additionally, "the said crystalline fraction" has been changed to the "said microcrystalline film comprises a crystalline fraction".

Thus, withdrawal of the objection is respectfully suggested.

Claims 12-13 and 15-16 were objected to for including informalities.

Again, Applicant appreciates the Examiner's suggestions with respect to these claims. The features of claim 12 and 13 are now recited in claim 11, which include the suggested subscripts, such as  $\text{SiO}_2$ . Claims 15 and 16 have been amended similarly.

Thus, withdrawal of the objection is respectfully requested.

Claim 17 was objected to because the fluxes recited lacked antecedent basis. This claim has been amended to correct this informality.

Thus, withdrawal of the objection is respectfully requested.

Claim 22 was objected to for not further limiting claim 11, as the features of claim 22 are already recited in claim 11. Accordingly, this claim has been cancelled.

Claims 24 and 25 were objected to informalities, which have been corrected according to the suggestions in the Official Action. Claim 26 was amended similarly.

Thus, withdrawal of the objection is respectfully requested.

#### **Objection to the Drawings**

The drawings were objected to for not illustrating a top gate transistor. However, Applicants respectfully disagree.

As disclosed, the transistor may be a bottom gate or top gate transistor, and for either situation the silicon film (5) is grown on the insulator (3) See, e.g., page 6, lines 21-25. As further described in lines 25-30, a top gate transistor is formed with drain electrodes (2) and a bottom gate transistor includes a substrate that comprises a gate electrode (2). As both electrodes are shown in Figure 1, both top and bottom gate transistors are illustrated by Figure 1.

Thus, withdrawal of the objection is respectfully requested.

**Claim Rejections-35 USC §103**

Claims 12-13 and 17-19 were rejected under 35 U.S.C. §112, second paragraph, as being indefinite. This rejection is respectfully traversed.

The features of Claim 12 (and 13), which are now recited in claim 11, considered indefinite for not defining "x: and "y". However, one of ordinary skill in the art would have recognized that the formula of a silicon nitride composition for  $\text{SiN}_x$ , and respectively to the chemical formula of a silicon oxy-nitride composition for  $\text{SiN}_x\text{O}_y$ , wherein "x" refers to the stoichiometric coefficient for nitrogen (N) and "y" refers to the stoichiometric coefficient for oxygen (O). Thus, while "x" and "y" do not have specific values assigned, the terms themselves do render the claims indefinite. Breadth of a claim is not to be

equated with indefiniteness. *In re Miller*, 441 F.2d 689, 169 USPQ 597 (CCPA 1971).

Claims 17-19 have been amended so that the claims recite their features in a definite manner.

Therefore, withdrawal of the rejection is respectfully requested.

**Claim Rejections-35 USC §103**

Claims 11-19 and 22-27 were rejected under 35 U.S.C. §103(a) as being unpatentable over NAKATA U.S. 6,078,059 ("NAKATA") in view of ROCA et al. ("ROCA") and YOSHINOUCI et al. US 5,403,756 ("YOSHINOUCI"). This rejection is respectfully traversed for the reasons below.

Independent claim 11 is directed to a method for producing a transistor, the transistor comprises:

- an insulator (3);
- a plasma treated interface (4) formed on top of the insulator; and
- a microcrystalline film (5) formed on top of the plasma treated interface.

The method includes the follow steps:

- the plasma for forming the plasma treated interface is formed using a gas selected from N<sub>2</sub>, O<sub>2</sub>, N<sub>2</sub>O and NH<sub>3</sub>; and
- the plasma treated interface is selected from SiN<sub>x</sub> layer, a SiN<sub>x</sub>O<sub>y</sub> layer, a SiO<sub>2</sub> layer and glass.

Thus, the gas used for forming the plasma for forming the plasma treated interface located between the insulator and microcrystalline film is not hydrogen ( $H_2$ ) plasma.

NAKATA describes a method for producing a thin film transistor (TFT) comprising a Layer of microcrystalline silicon deposited on top of an insulating layer. As argued previously, the process of Nakata results in a microcrystalline silicon layer having a crystalline fraction of 70%, at best (Col. 6, L. 65 to Col.7 L.4). The insulating  $Si_3N_4$  layer is formed by applying a plasma discharge to a mixture of gases comprising monosilane  $SiH_4$ , ammonia  $NH_3$ , and  $H_2$ . (Col.8 L.61 to col.9 L.5). The microcrystalline silicon is obtained by a layer by layer technique alternating a silane plasma and a hydrogen plasma (Col. 9, L.3-17).

Therefore, the insulating layer top surface and the microcrystalline silicon are both exposed to a plasma containing hydrogen ( $H_2$ ).

However, NAKATA does not disclose applying a plasma treatment to the top surface of the  $Si_3N_4$  layer, said plasma being formed using a gas selected from  $N_2$ ,  $O_2$ ,  $N_2O$  and  $NH_3$ .

Thus Claim 11 differs from NAKATA in that:

- (i) the crystalline fraction of microcrystalline silicon is above 80%, and
- (ii) a plasma treated interface is formed between the insulator layer and the microcrystalline film by a plasma formed using a gas selected from  $N_2$ ,  $O_2$ ,  $N_2O$  and  $NH_3$ .

ROCA discloses a top gate TFT comprising a conducting ITO layer covered by a 20 nm thick a-Si:H layer, on top of which is deposited a silicon microcrystalline film (paragraph II on page 7080). The microcrystalline film does not seem to be formed on top of an insulating layer. The transistor obtained appears to have a low mobility, e.g., less than  $0.64 \text{ cm}^2/\text{Vs}$  (table 11, page 7081).

ROCA fails to disclose treating an interface between an insulating layer and a microcrystalline silicon film by a plasma formed using a gas selected from  $N_2$ ,  $O_2$ ,  $N_2O$  and  $NH_3$ . ROCA also fails to disclose either an interface layer (selected from  $SiN_x$  layer, a  $SiN_xO_y$  layer, a  $SiO_2$  layer and glass) between an insulating layer and a  $\mu\text{-Si}$  film.

Thus, ROCA is unable to remedy the shortcomings of NAKATA for reference purposes.

YOSHINOUCHI describes a process for making a TFT comprising a micro- or poly-crystalline silicon film, comprising the steps of: deposition of a semiconductor film on a  $SiO_2$  insulating layer, forming a passivation layer on the semiconductor and applying a hydrogen plasma treatment for

implanting hydrogen ions into the semiconductor film in order to obtain a polycrystalline semiconductor film.

However, YOSHINOUCI fails to disclose forming a plasma treated interface between the insulating bottom layer and the microcrystalline silicon film, by applying a plasma formed using a gas selected from the group consisting of:  $N_2$ ,  $O_2$ ,  $N_2O$  and  $NH_3$ .

Thus, YOSHINOUCI also fails to remedy the shortcomings of NAKATA for reference purposes.

Accordingly, the combination of NAKATA, ROCA and YOASHINOUCI fails to teach the invention of claim 11, and, thus dependent claims 14-19 and 22-27.

This combination also fails to even suggest the claimed invention.

NAKATA fails to disclose a fabrication method for films with microcrystalline fraction above 80%.

ROCA discloses a fabrication method enabling to obtain microcrystalline silicon films having a high crystalline fraction, wherein hydrogen plasma is applied to amorphous silicon layer, in order to obtain microcrystalline silicon film having a high crystalline volume fraction.

However, none of the applied documents suggest treating an interface between an insulating layer and a microcrystalline silicon film, by applying plasma formed using a gas selected from:  $N_2$ ,  $O_2$ ,  $N_2O$  and  $NH_3$ , the interface layer being selected from a  $SiN_x$  layer, a  $SiN_xO_y$  layer, a  $SiO_2$  layer and glass.

Moreover, none of these documents suggest that such a plasma treated interface could increase TFT mobility.

On the contrary, one of ordinary skill in the art would have been discouraged from applying a plasma other than the usual hydrogen based plasma for treating the interface of a microcrystalline silicon film, because it is common to use a hydrogen plasma treatment for increasing the crystalline fraction of silicon.

Furthermore, none of these documents suggest treating an interface between an insulating layer and a microcrystalline layer with a plasma formed using a gas from:  $N_2$ ,  $O_2$ ,  $N_2O$  and  $NH_3$ .

Therefore, the proposed combination fails to disclose or even suggest the claimed invention, and withdrawal of the rejection is respectfully requested.

### **Conclusion**

In view of the amendment to the claims and the foregoing remarks, this application is in condition for allowance at the time of the next Official Action. Allowance and passage to issue on that basis is respectfully requested.

Should there be any matters that need to be resolved in the present application, the Examiner is respectfully requested to contact the undersigned at the telephone number listed below.

The Commissioner is hereby authorized in this, concurrent, and future submissions, to charge any deficiency or



credit any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

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